

The Pesticides Program Activities of the Public Health Service

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PESTICIDES have made significant contributions toward elevating our standard of living during the 20th century. They have controlled malaria, typhus, dysentery and diarrhea, plague, and other diseases transmitted by insects. They have also brought vast economic and social benefits through better health and increased quantity and quality of foodstuffs, feed, and fiber products.

In less than 20 years, the use of synthetic chemical pesticides in the United States has increased from a level of a few million pounds a year to nearly 1 billion pounds annually. Almost 60,000 pesticide formulations are now registered in the United States, and each of these contains one or more of the approximately 800 different pesticide compounds.

The increased production and use of pesticides, accompanied by heightened public interest in contamination of the environment by these compounds, led to the establishment of a focal point within the Public Health Service

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At the time this report was prepared, the Food and Drug Administration was not a part of the Public Health Service; therefore, its work in the field of pesticides is not included.

for assessing the total impact of pesticides upon human health. This responsibility is assigned to the Pesticides Program of the National Communicable Disease Center.

For many years the Service has taken an active interest in the health aspects of pesticides. Early studies on the agricultural pesticide, lead arsenate, were carried out by scientists from the National Institutes of Health.

The National Communicable Disease Center began work on pesticides in 1949, with the establishment of a toxicology laboratory at Savannah, Ga. Since that time the activities of this laboratory have been focused on continuous research concerning the safety and effectiveness of pesticides for the control of vectorborne diseases. Early studies helped to demonstrate the safety of DDT and thus permit its use against vectors of diseases such as malaria, typhus, and plague. Research has also included medical study of farmers, aerial sprayers and ground applicators of pesticides, and employees of pesticide manufacturing plants whose work necessitated intense and prolonged exposure to pesticides. Similar studies have been made of volunteers who received known doses of important pesticides. Many cases of accidental and occupational poisoning have been investigated. The storage and excretion of pesticides and their metabolites have also been measured in the general population and in persons whose exposure to pesticides was exceptionally high.

The Office of Pesticides, established in Novem-

ber 1964, provided a mechanism for responding to a number of health-related recommendations which followed a comprehensive study of the benefits and hazards of pesticides by the Life Sciences Panel of the President's Science Advisory Committee. In August 1966 the Office of Pesticides was transferred from its Washington, D.C., headquarters to its present site at the National Communicable Disease Center in Atlanta and consolidated with the toxicological activities of the Center. This new organization was named the Pesticides Program. (On July 1, 1968, the Pesticides Program was transferred to the Food and Drug Administration.)

The understanding of the ultimate impact of pesticides on human health requires the efforts of workers in many disciplines. In addition to research on the assessment of long term and short term effects of these compounds on people, the research personnel are aiming at corrective solutions to pesticide-health problems.

The work of the Pesticides Program is carried out in community studies; State programs, which include monitoring of air and people; and research laboratories. The sites of these activities are shown on the map.

Community Studies on Pesticides

The community studies on pesticides consist of epidemiologic and ecological studies in selected areas of heavy pesticide usage throughout the United States and Puerto Rico. Sixteen of these studies, which are carried out under contract with State and local health departments and universities, are now underway. Within each study area a pesticide-usage profile is developed. Data are obtained continuously on the types and quantities of pesticides used; the time, location, and method of application; and the purpose for which they are used. Concurrently, levels of pesticides and their metabolites in people and environmental media are determined. These data should eventually provide information on the movement of pesticides in the environment and their routes of entry into man, the importance of potential sources of contamination for man, as well as clues to the metabolic fate, excretion, and deposition of pesticides.

Investigators assigned to these projects study people who receive heavy exposure to pesti-

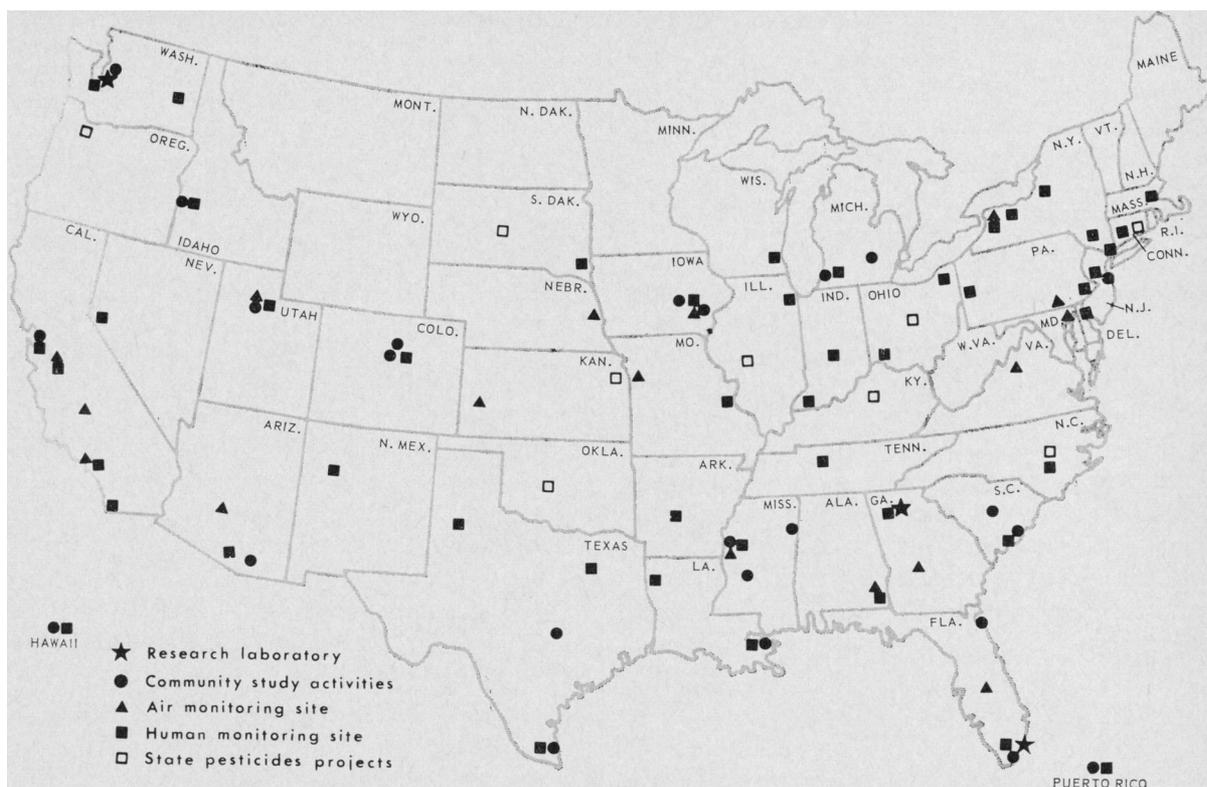
cides; for example, workers in pesticide formulating plants, pest control operators, greenhouse workers, and aerial spray pilots. Study procedures for each participant generally include a detailed history of pesticide exposure and usage, a complete medical history and physical examination, and hematological and biochemical tests. Pesticide residue analyses are performed on urine and blood and, when samples are available, on adipose and other tissues. Through this complete spectrum of studies of various population groups, information is sought on the potential effects of exposure and use in terms of disease induction.

Community studies have led to development of laboratory competence in pesticide analysis and allied tests, and each community laboratory performs all testing for its own area. All laboratories participate in a quality control program that is designed to insure a satisfactory standard of technical performance. Concurrently, the Pesticides Program provides technical support, which includes repository services for reference pesticides, analytical quality control, methodology research, and training in analytical methodology.

Generally, community studies are undertaken in areas where pesticides are applied frequently and in large amounts. Because of the wide variation in climates, growing seasons, and agricultural practices in these areas, the long term effects of pesticides can be studied under varying conditions.

The Texas study is in the agricultural area in the southern tip of the State where warm temperatures and modern irrigation practices permit an unusually long growing season. Massive amounts of insecticides, herbicides, and defoliants are applied by aerial sprayers and ground applicators. Numerous persons are occupationally exposed, and acute illnesses frequently occur as a result of accidental exposure. These illnesses are investigated by the study personnel. Exposed persons are kept under biochemical, medical, and physiological surveillance and hospitalized when necessary.

The characteristics of the site of the Idaho study differ greatly from the Texas site. In this area pesticides are applied in large amounts during a comparatively short growing season. Research also includes close surveillance of ex-



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posed persons, especially those who reside near heavily treated areas.

The New Jersey community study is in a highly industrialized area. Here, intensive surveillance is maintained of persons involved in the manufacture and formulation of pesticides. The South Carolina study also closely follows the employees of formulating and manufacturing plants, in addition to the study of farm families and persons involved in the application of pesticides.

The Florida study is continuing a statewide program designed to maintain liaison with all structural pest control operators, even after they have left the industry, to determine their health status over a period of years. In the Dade County area, where large amounts of organic phosphorus insecticides are used extensively, a number of pesticide poisonings occur. The Florida project studies biochemical and physiological changes in poisoned persons and is also concerned with improving patient management and therapy.

The Iowa community study is seeking a pos-

sible causal relationship between pesticide exposure and prolonged recovery time of pesticide-exposed surgical patients who have received the muscle relaxant, succinylcholine. Other studies underway deal with man's exposure to pesticides through his food chain—investigating levels of pesticides in people as related to pesticides and their metabolites present in locally grown livestock and other foods.

In addition to the studies of occupationally exposed workers, the Mississippi study maintains close surveillance on pilots of pesticide spray planes, since 26 percent of all U.S. fatal crashes of spray planes in 1964–66 occurred in the area of the Mississippi River Delta. All community study projects investigate crashes of pesticide spray planes. The investigations are carried out under an agreement with the Bureau of Aviation Safety and the Federal Aviation Administration of the Department of Transportation.

The Michigan and Washington State community studies are in the center of fruitgrowing regions. These studies are concerned with

the effect of spraying operations on orchardists and people living adjacent to fruit orchards. Also, the Washington project is re-examining approximately 1,000 persons who had prolonged occupational exposure to lead arsenate and were originally studied in 1938 by Dr. Paul Neal of the National Institutes of Health.

The Louisiana study is concerned with agricultural workers and family units in southeastern Louisiana and pest control operators in New Orleans. All community studies include long term surveillance of population segments receiving heavy exposure to pesticides. Also, each study acquires ecological data on the movement of pesticides in the environment of its area.

The Puerto Rico project is determining the types and amounts of pesticides used there, characterizing the populations heavily exposed to pesticides, and considering the morbidity and mortality data in view of pesticide use patterns.

The Hawaii community study, in Oahu, is conducting an islandwide survey of the possible relationship between maximal daily household use of pesticides and certain chronic respiratory diseases. In addition, a study is presently being conducted on the relationship of pesticides to cardiovascular disease, asthma, bronchitis, and sinusitis. This is carried out in cooperation with the National Institutes of Health Hawaiian cardiovascular study and the Hawaii Department of Health.

The Utah study, at Salt Lake City, provides regular medical and biochemical surveillance of occupationally exposed workers who apply pesticides to the extensive marshy lake beds characteristic of the Great Salt Lake Basin area. It also proposes to analyze water, fish, and muck in watershed areas.

In Weld County, Colo., location of the Colorado community study, a multiple regression study is being made to determine the source of families' exposure to pesticides. Potential sources—house dust, soil, food, water, and drift from treated fields—are evaluated. These family units are under continuous medical and biochemical surveillance.

The Arizona community study is comparing pesticide exposure levels, pesticide concentrations in blood, and clinical characteristics (physical and biological) in five urban and five rural families. The rural families reside in an

area which is sprayed intensely in the summer months. Close surveillance is also maintained on aerial spray pilots and loaders for total DDT levels in blood as well as cholinesterase levels. Current knowledge indicates that these workers, particularly loaders, receive the highest exposure to DDT and the cholinesterase-inhibiting compounds.

In California, studies include blood dyscrasias in a sample of the population regularly exposed to lindane and the possible causal relationship between seasonal neonatal jaundice in the Imperial Valley and the use of cotton defoliant.

The data gathered from the various community study projects will eventually form the basis for a clearer understanding of the benefit versus risk equation of pesticides as related to human health.

State Services Program

A major goal of the Pesticides Program is to help the States improve their technical capabilities in dealing with the public health aspects of pesticides. Assistance and guidance are currently being given through various training and consultation activities, ranging from formal courses in analytical techniques to consultation on legal aspects of pesticide application and use. In addition to training courses on the chemistry and measurement of pesticide residues, organized courses and on-the-job training are offered in the epidemiology, diagnosis, and treatment of pesticide poisoning. Also, persons who perform or supervise pest control operations are instructed in the health hazards of pesticides encountered in their particular work.

Courses are conducted in Atlanta, Ga.; Perrine, Fla.; and Wenatchee, Wash., where laboratory staff members and equipment are used as integral components in the training program. Courses are also given in cooperation with State and local health departments. The first course of this kind was given recently in conjunction with the New York City Department of Health, and others are scheduled. More than 350 physicians, scientists, administrators, educators, and businessmen who have varying interests in pesticides and health attended these courses in 1967.

In tandem with the various courses offered,

films, slides, educational exhibits concerning health aspects of pesticides, and various types of printed information material are available to interested groups. A new film entitled "Perspective on Pesticides" is available to each State health department.

Legal consultation is offered to States, upon request, concerning specific problems of legislation, enforcement, and uniform regulations with respect to pesticides. Evaluation of State pesticide laws, recommendations for more complete and efficient State and Federal statutes, and continuing legal guidance to the Pesticides Program staff are among the activities undertaken by the State Services program.

Another function of the State Services program is systematic monitoring of pesticide levels in a broad sample of the general U.S. population. People are being monitored by the analysis of tissues collected from post mortem examinations and from tissues excised in the normal course of surgery. Limited clinical data are obtained for each specimen. Tissues are being collected at more than 70 selected hospitals throughout the United States and sent to contract laboratories for analytical testing. To assure comparability of results, procedures are standardized for the collection and handling of tissues, analytical methods and equipment used, and the reporting of information. Because of limitations in the availability of practical analytical procedures, sampling is limited to adipose tissue and blood serum, and testing at this time is restricted to chlorinated hydrocarbon residues. However, as procedures are developed and evaluated, additional tissues may be used and testing will be conducted for other compounds.

Air across the country is being monitored to provide information about the extent and severity of pesticide contamination of the atmosphere in order to evaluate the importance to man of this route of exposure to pesticides. The areas selected for air sampling represent different conditions of pesticide use as well as climatic variations. Determinations are made of pesticides present both as vapors and particulates, and meteorological factors and diurnal variations are also studied. Data from this study will subsequently be used to evaluate the need to monitor pesticides in air in other selected key

areas throughout the country. Efforts are also being directed toward the development of a mobile automatic air sampler-analyzer.

Another aspect of the State Services program is the collection, storage, and dissemination of information and data related to the health aspects of pesticides. The two principal types of information are research data from all sections of the Pesticides Program and references to published work. The references include, as far as possible, worldwide publications relating to the health aspects of pesticides. Data from the research laboratories, the monitoring of people and air, and the community studies are statistically analyzed, coded, and stored by computers for retrieval. Statisticians in the State Services program assist other sections of the Pesticides Program in solving problems of statistical design and analysis of data.

The State pesticides projects are a new function of the State Services program. Their purpose is to determine pesticide-related health problems within the States and to improve State and local competency in handling these problems. Each project consists of a multifaceted program including training in the safe use of pesticides, surveys to develop pesticide usage profiles, pesticide legislation review, environmental (air) monitoring, monitoring of people, morbidity and mortality reporting, and comprehensive planning and activating of programs on the public health aspects of pesticides. The projects are being conducted by a Public Health Service employee assigned to a State or under contracts whereby a State employs someone to conduct the program. Presently, project leaders are on duty in Connecticut, Illinois, Kentucky, Ohio, Oklahoma, Oregon, and South Dakota. Negotiations are also underway with other States; plans call for the development of 13 of these projects.

Research Laboratories

Toxicology Laboratory. The Atlanta-based Toxicology Laboratory is the primary center within the Public Health Service for studying effects of pesticides on human health and for developing and testing improved methods to diagnose and treat pesticide poisoning in man. The research program is aimed principally at the development of new data on acute and

chronic toxicity of economic poisons. This laboratory also conducts studies of people who suffer heavy environmental exposure to pesticides and of volunteers who are experimentally exposed in order to determine toxic influences on their health status and to measure total body burdens of pesticides and their metabolites. Improved diagnosis and treatment of pesticide poisoning are sought through tests with experimental animals, from studies of poisoning cases, and by research on the mode of action of compounds.

The Atlanta laboratory gives emphasis to studies on man. Two such studies have included daily feeding of known doses of DDT to volunteers. The doses given ranged up to 200 times the level being ingested by the general population as a residue in its daily diet. Feeding of this amount of DDT for periods up to 21 months did not produce detectable harmful effects, as indicated by periodic physical examinations throughout the dosage period and by clinical and laboratory tests. During these studies, a method was devised to measure DDT absorption which included urinary excretion of the DDT metabolite, DDA.

These earlier studies on volunteers increased the value of a more recent study of 35 men who had formulated DDT for 11 to 19 years, because they provided information on the relationship between dosage on one hand and storage and excretion on the other. The average absorption of the compound by 20 of the men judged to have received heavy occupational exposure was more than 400 times greater than the current absorption by the general population.

Continuing studies with experimental animals are concerned with determination of the acute and long term dermal and oral toxicity of compounds presently in use or proposed for use as pesticides. In one study, monkeys were fed various levels of DDT in their diet for more than 7 years and studied to determine effects.

Pesticides Research Laboratory (Western). The Western laboratory is located in Wenatchee, Wash. Scientists at this laboratory study health hazards associated with the use of pesticides. The intensive use of pesticides in the fruit orchards of this area and the fact that many residents have their homes adjacent to orchards provide ample opportunity for field

study of both occupational and environmental exposure to a number of pesticides.

Emphasis at the Western laboratory is given to the measuring of exposure to pesticides of manufacturing personnel, formulators, applicators, and other environmentally exposed population groups; to measuring absorption of compounds under use and exposure conditions; and to correlation of exposure data with physiological and clinical effects in the persons exposed. Studies are also made of cases of pesticide poisoning which occur in the Western States. The laboratory provides technical assistance to community study projects and to State and local health departments in the Western States.

Investigators at the Western laboratory have made a number of significant contributions to the knowledge of health hazards in the use of pesticides. One multifaceted study included determination of general contamination of the environment with DDT. The storage level of this compound in body fat of the general population was determined to be about 4 ppm, with a range from 0.7-25.4 ppm. Levels in persons receiving environmental exposure were found to be not significantly higher than those in the general population. However, levels in persons receiving occupational exposure increased in direct correlation to the intensity of exposure. Analysis of complete meals indicated that the general population ingests about 0.04 mg. of DDT per day in food. Calculations indicate that this amount is sufficient to account for most or all of the storage level detected. The DDT content of women's breast milk was found to be about 0.1 ppm in whole milk or about 2 ppm in the fat moiety.

Investigators at the laboratory have also developed methods for measurement of dermal and respiratory exposure of workers to pesticides. These methods have been applied to approximately 10 pesticides under 31 different conditions of use. Studies are made of protective clothing and masks which might reduce exposure of workers. Before its general adoption as an approved drug, 2-PAM, the antidote for poisoning by organic phosphorus compounds, was made available to physicians and hospitals in the Northwest. Some 50 poisoning patients have been treated with this drug. The favorable results of this treatment provided

valuable support for the ultimate acceptance of the antidote as an approved prescription drug.

Pesticides Research Laboratory (Florida). The Pesticides Research Laboratory at Perrine, Fla., is the primary reference, quality control, and methodology research facility for all sampling and analytical methods used by the Pesticides Program. This laboratory also is a major center for training personnel in pesticides analytical methodology; its staff is responsible for keeping pace with advances in analytical techniques. The rapid advancement of pesticide analytical chemistry in recent years has brought major improvements in the sensitivity of instruments and methodology. The introduction of gas chromatography in particular, and the availability of various selective types of detectors, now make it possible to determine micro-concentrations of pesticides in the parts per billion range and, in some instances, in parts per trillion.

A prime effort of the staff is to make new and improved reliable analytical procedures available to the laboratories of the community study projects and those of State and local health agencies which assess pesticide residues in people and the environment.

The laboratory is also concerned with research on the fate and metabolism of pesticides in animals in order to determine their physiological, anatomical, and genetic effects. The data collected will be used as an index to new knowledge of the impact of pesticides on the health of man. This laboratory conducts studies on the acute and chronic toxicity of pesticides to mammals, with emphasis on studies of chronic effects. Research includes studies on biochemical and other pesticide-induced changes which may directly or indirectly lead to diseases in man. Special investigations are underway using squirrel monkeys and rhesus monkeys.

Registration of Pesticides

Federal law requires that all pesticides be registered with the U.S. Department of Agriculture before they can be sold in interstate com-

merce. The Pesticides Program reviews pesticide registration applications with respect to the human health hazards which may result directly or indirectly from the proposed uses of these compounds.

Under a three-way agreement by the Departments of Agriculture, Interior, and Health, Education, and Welfare, the staff of the Pesticides Registration Section in Washington, D.C., reviews the applications from the standpoint of possible hazards to human health that would result if the registration were granted. Particular attention is given to the accuracy in labeling and cautionary statements; directions for use, dosage, formulation, and mode of application; persistence of the compounds; purpose of proposed use; hazards to applicators and the public during and after the application; and the degree of environmental contamination that may result from the proposed use. In the review process, emphasis is placed on evaluating the acute and chronic toxicity data on all active pesticide ingredients including skin absorption, inhalation, potentiation, and synergistic properties. An average of 300 applications are received weekly. Other technical personnel within the Pesticides Program provide valuable supportive data on the toxicity of pesticides and on the levels of these compounds in man and the environment.

Conclusion

The Pesticides Program of the Public Health Service is concerned with the assessment of the total effects of pesticides on the health of man in order to deal effectively with health problems associated with the use of pesticides. This mission requires the efforts of many trained persons, in various disciplines, in order to provide the basic laboratory research, epidemiologic and ecological studies, as well as consultation, training, and information services needed to evaluate more completely the risks entailed in the use of pesticides against the background of their great benefits.